Georgia Tech Sponsored Research

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Project director	Pearson James
Research unit	CEE
Title	Emission Testing of a Fuel Additive
Project date	9/30/2000

E-20-F61
#1

Emission Testing of a Fuel Additive

Final Report to:

Environmental Fuels, Inc.
6928 Sonny Dale Dr.
Unit C
West Melbourne, FL

Prepared by:

James Pearson
Air Quality Laboratory
Georgia Institute of Technology
Atlanta, GA

THE AIR QUALITY LABORATORY

Introduction

Environmental Fuels, Inc. (West Melbourne, FL) requested that the Georgia Institute of Technology Air Quality Laboratory (AQL) conduct emission testing to evaluate the effectiveness of a gasoline additive at reducing vehicle emissions and improving vehicle fuel economy. All vehicle testing was conducted at the AQL dynamometer facility in Riverdale, Georgia under controlled conditions. Mileage accumulation was conducted onroad by AQL employees. The gasoline used for the study was in-use unleaded fuel supplied by AQL. Three vehicles were selected by AQL for the testing program. These vehicles widely varied in age, mileage and engine class.

Equipment

All vehicle testing was conducted at the AQL chassis dynamometer laboratory in Riverdale, Georgia. Test procedures are run on a Clayton 8 5/8" dual roll, hydrokinetic chassis dynamometer. During the test procedures vehicle emissions are collected with a constant volume sampler, CVS (CVS-20, Horiba Instruments, Inc., Irvine, CA). The CVS dilutes a portion of the tailpipe exhaust with ambient air that has been filtered and then delivers a constant volume of this mixture to a Teflon bag for subsequent chemical analysis. In addition to the dilute exhaust sample, the CVS also collects a sample of the ambient background emissions for comparison. To evaluate the effects the catalyst might have on changes in emissions for both the baseline and additive tests, sampling was also conducted before the catalyst. This raw engine-out testing was on a second-by-second basis to evaluate how emissions change with the driving cycle.

After the vehicles have been run on the dynamometer, the bag samples are analyzed with a dilute bag bench, (Series 200, Horiba Instruments, Inc.). The bench contains instruments for the analysis of carbon dioxide (CO_2), carbon monoxide (CO), total hydrocarbons (THC), Methane (CH_4), and nitrogen oxides (NO_x). Both CO and CO_2 are measured by non-dispersive infrared (NDIR) instruments. A flame-ionization detector (FID) is used for THC and CH4. Nitrogen oxides are measured via ozone-chemiluminescence. All the instruments are calibrated by dynamic-dilution of NIST-traceable primary standards over the range of interest.

All emission and dynamometer testing are conducted in accordance with manufacturers and EPA specifications. Dynamometer coast-downs are conducted for each vehicle weight setting and the CVS flow is verified by propane injections with a critical flow orifice.

Vehicles

Three vehicles of widely varying age, mileage and engine class were selected by Genirev for this testing program. Table 1 provides a summary of these three vehicles listed by model year. Included in Table 1 are the dynamometer settings for inertial weight and indicated horsepower. Photos of each vehicle during testing are provided in Appendix A.

Table 1. Vehicle Specifications						
Make	Model	Year	Mileage	Engine	Inertial Wt	iHp
Pontiac	Sunbird	1994	191880	2.0L	3000	4.7
Ford	Taurus	1995	34050	3.0L	3500	4.9
Ford	F-150	1994	84640	5.0L	5250	13.1

Experimental Protocol

Each vehicle was inspected upon reception at the laboratory. The vehicles were drained of fuel and the specially formulated test fuel (Specialty Fuels, Texas, 87 octane) was added.

Two baseline test procedures were run on each vehicle. The First test procedure used was the U.S. EPA Federal Test Procedure (FTP-75) based on the urban dynamometer driving schedule (UDDS). After the vehicles have been prepped they are allowed to soak for at least 12 hours at a constant temperature before the test is conducted. The FTP consists of a cold start UDDS, a 10-minute soak and then a hot start repeat of the first 505 seconds (hills 1-5) of the UDDS. The drive cycle of the FTP is shown in Figure 1. During the FTP, dilute exhaust emissions are collected in three separate bags. Bag 1 is the cold transient drive and consists of the first 505 seconds. Bag 2 is the Cold stabilized drive and consists of the next 866 seconds. No exhaust sample is collected during the 10 minute soak period. Bag 3 is the hot transient drive (also known as the hot-505) and is the last 505 seconds of the test.

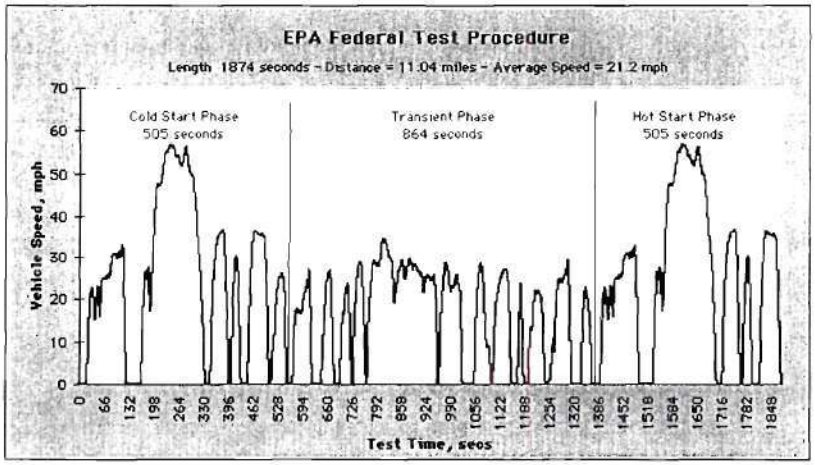


Figure 1. The Federal Test Procedure

After each vehicle had been run on the FTP cycle, the fuel was drained and new test fuel along with an initial high dose of the additive was placed in each vehicle. The vehicles were then driven approximately 1000 miles over the next few days under the supervison of an AQL employee. No modifications were made to the vehicles during the mileage accumulation stage. All vehicles were refueled using the test fuel and 1 oz. per gallon of additive during the mileage accumulation. After the mileage accumulation stage, the fuel was again drained from the vehicles and replaced with test fuel and additive in the quantity of 1 oz per gallon of fuel.

Results
Emissions

During the FTP, three bags of diluted exhaust gas are collected for each vehicle and then analyzed for CO, CO_2, NO_x, THC and CH_4. The exhaust emissions are first measured on a volume basis and are then these numbers are converted to mass basis (grams/mile) based on the distance the vehicle traveled during the test. The final emission numbers are then weighted for the cold and the hot emissions relative to actual driving conditions. The emissions from Bags 1 and 2 are summed and then weighted by 43% and the emissions from Bags 2 and 3 are summed and weighted by 57%.

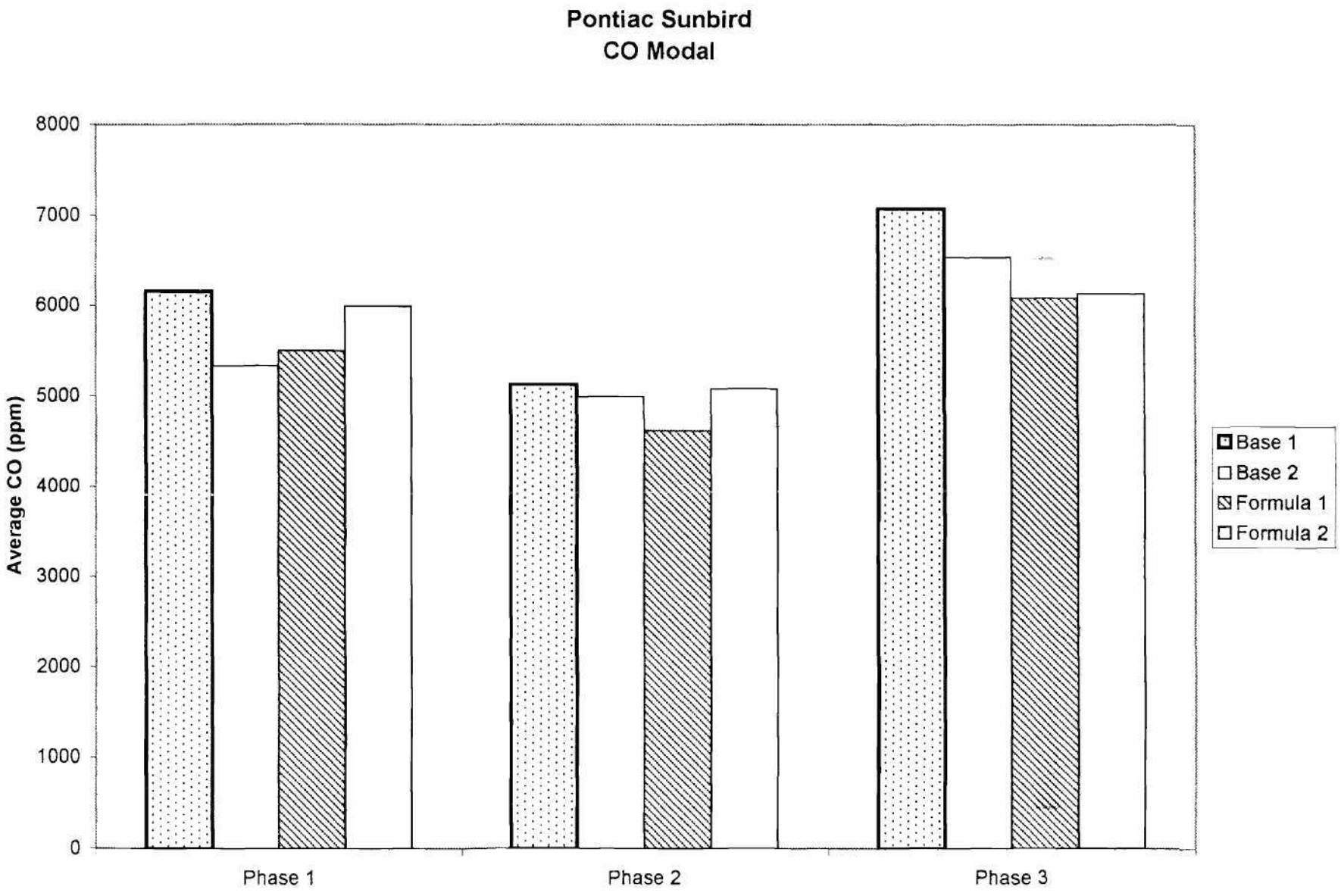
The bag results for the three vehicles are provided in Tables 2-4 for the 4, 6 and 8 cylinder vehicles, respectively. Both the 4 and 8 cylinder vehicles showed a significant reduction in NOx emission but at the same time, an increase in CO emissions over the baseline values.

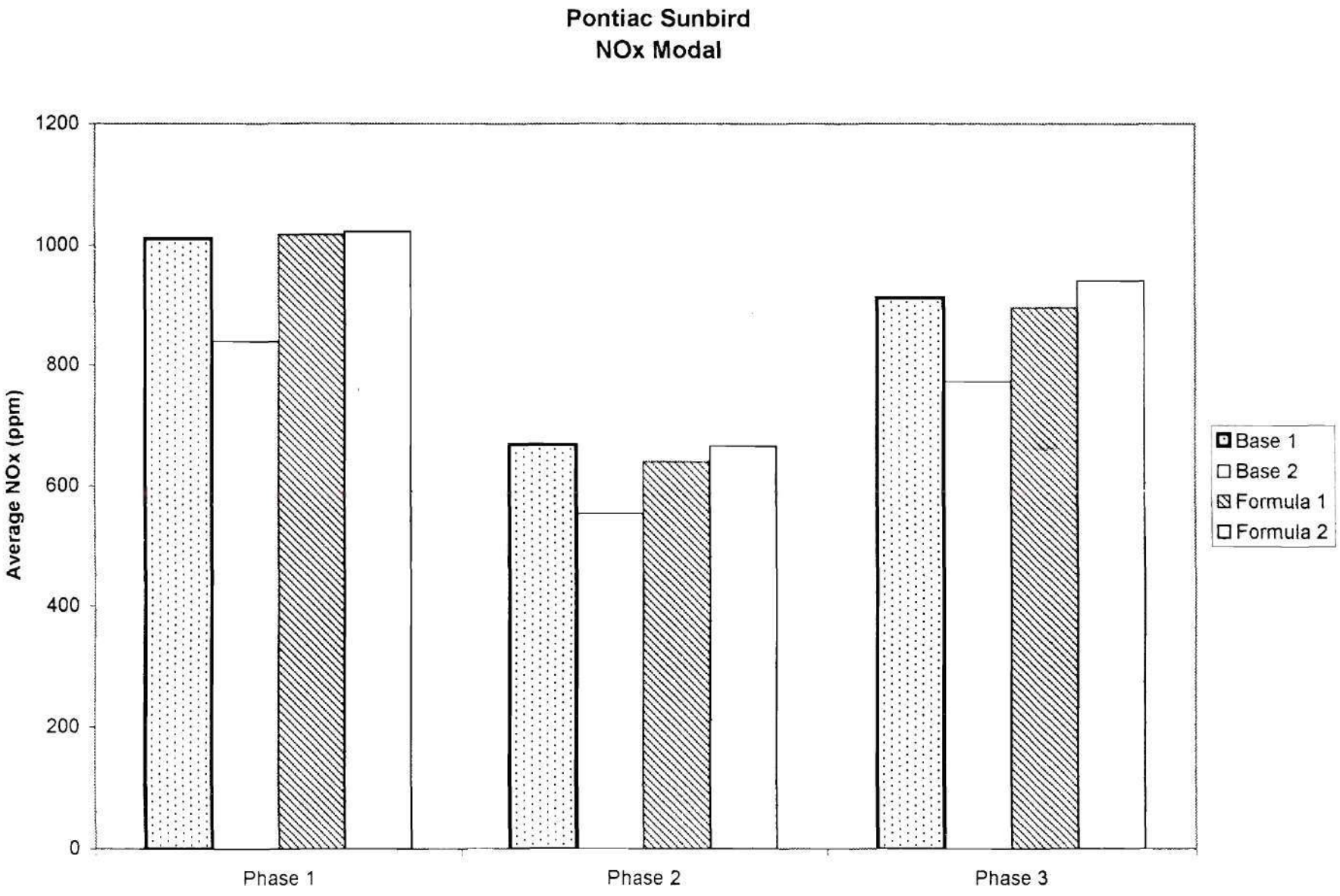
The average emissions of the raw engine-out analysis for the 4 cylinder Pontiac Sunbird are provided in Figures 1-3 for CO, NOx and Total Hydrocarbons, respectively. The results from the 6 cylinder Ford Taurus for CO, NOx and Total Hydrocarbons are provided in Figures 4-6, respectively. The average CO, NOx and Total Hydrocarbons for the 8 cylinder Ford F-150 are provided in Figures 7-9, respectively. As can be seen from the engine-out graphs, the changes (either positive or negative) are very small when comparing the fuel additive to the baseline runs.

Table 2. Bag Results for the 4 cylinder Pontiac Sunbird					
	CO	HC	NOx	CO2	MPG
Baseline #1	6.589	1.313	1.183	343	24.98
Baseline #2	6.386	1.221	1.092	340	25.23
Baseline Avg.	6.488	1.267	1.138	341.5	25.11
Post-Additive #1	6.714	1.216	.724	326.2	25.90
Post-Additive #2	6.694	1.462	.831	330.3	25.54
Post-Additive Avg.	6.704	1.339	.778	328.25	25.72
Percent Change	3.30	5.68	-31.63	-3.88	2.43

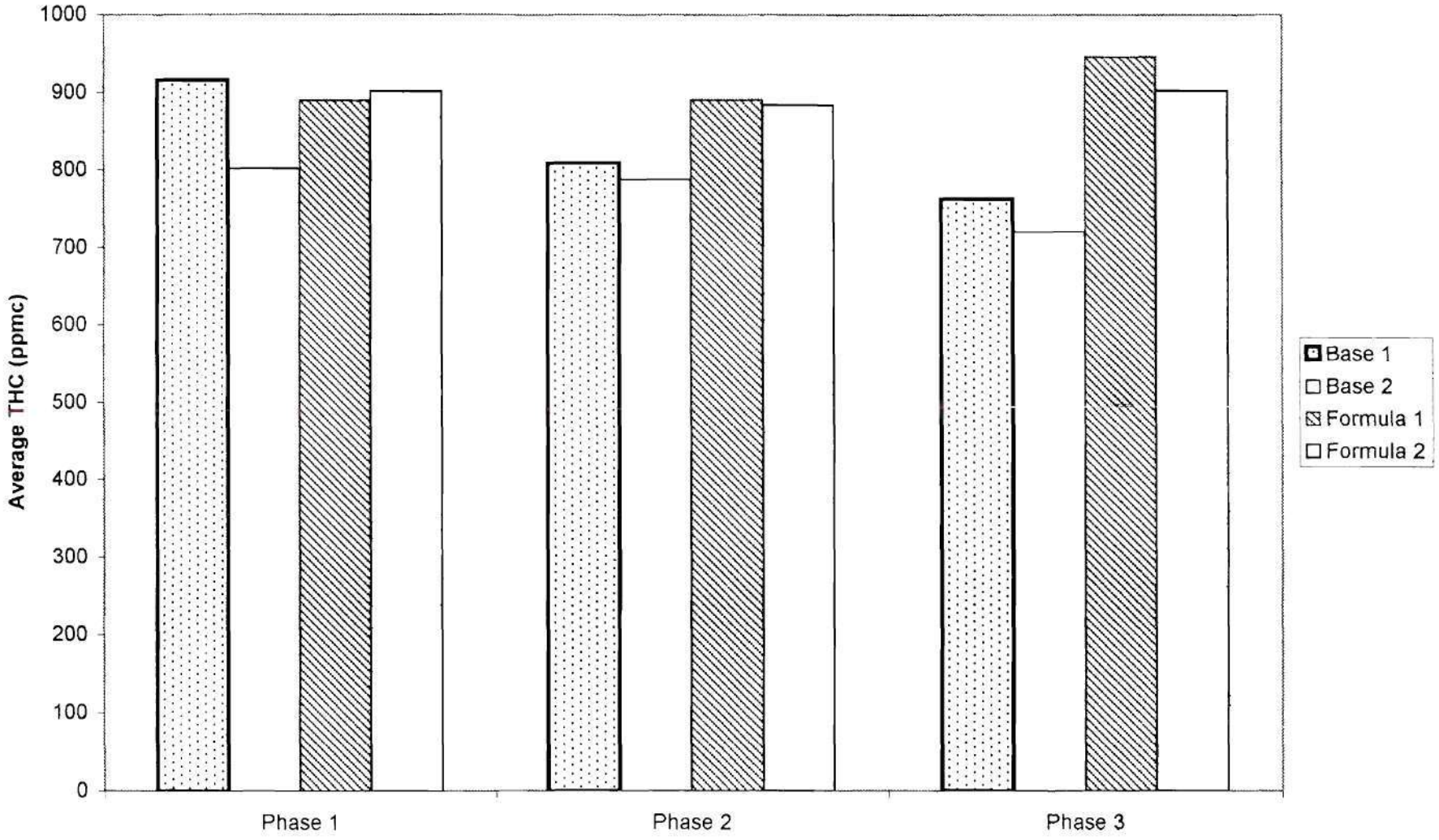
Table 3. Bag Results for the 6 cylinder Ford Taurus					
	CO	HC	NOx	CO2	MPG
Baseline #1	2.751	.221	.404	420.6	20.98
Baseline #2	2.521	.164	.414	389.9	22.64
Baseline Avg.	2.636	.193	.409	405.3	21.81
Post-Additive #1	2.468	.21	.481	389.7	22.65
Post-Additive #2	2.436	.223	.474	383.8	23.00
Post-Additive Avg.	2.452	.217	.478	386.8	22.83
Percent Change	-6.98	12.44	16.87	-4.56	4.68

Table 4. Bag Results for the 8 cylinder Ford F-150					
	CO	HC	NOx	CO2	MPG
Baseline #1	3.561	.618	.824	550.4	16.0
Baseline #2	3.711	.573	.778	556.9	15.82
Baseline Avg.	3.636	.600	.801	553.7	15.91
Post-Additive #1	3.824	.548	.577	549.5	16.03
Post-Additive #2	3.684	.472	.726	556.3	15.65
Post-Additive Avg.	3.754	.510	.652	552.9	15.84
Percent Change	3.25	-15.0	-18.6	-0.14	-0.44

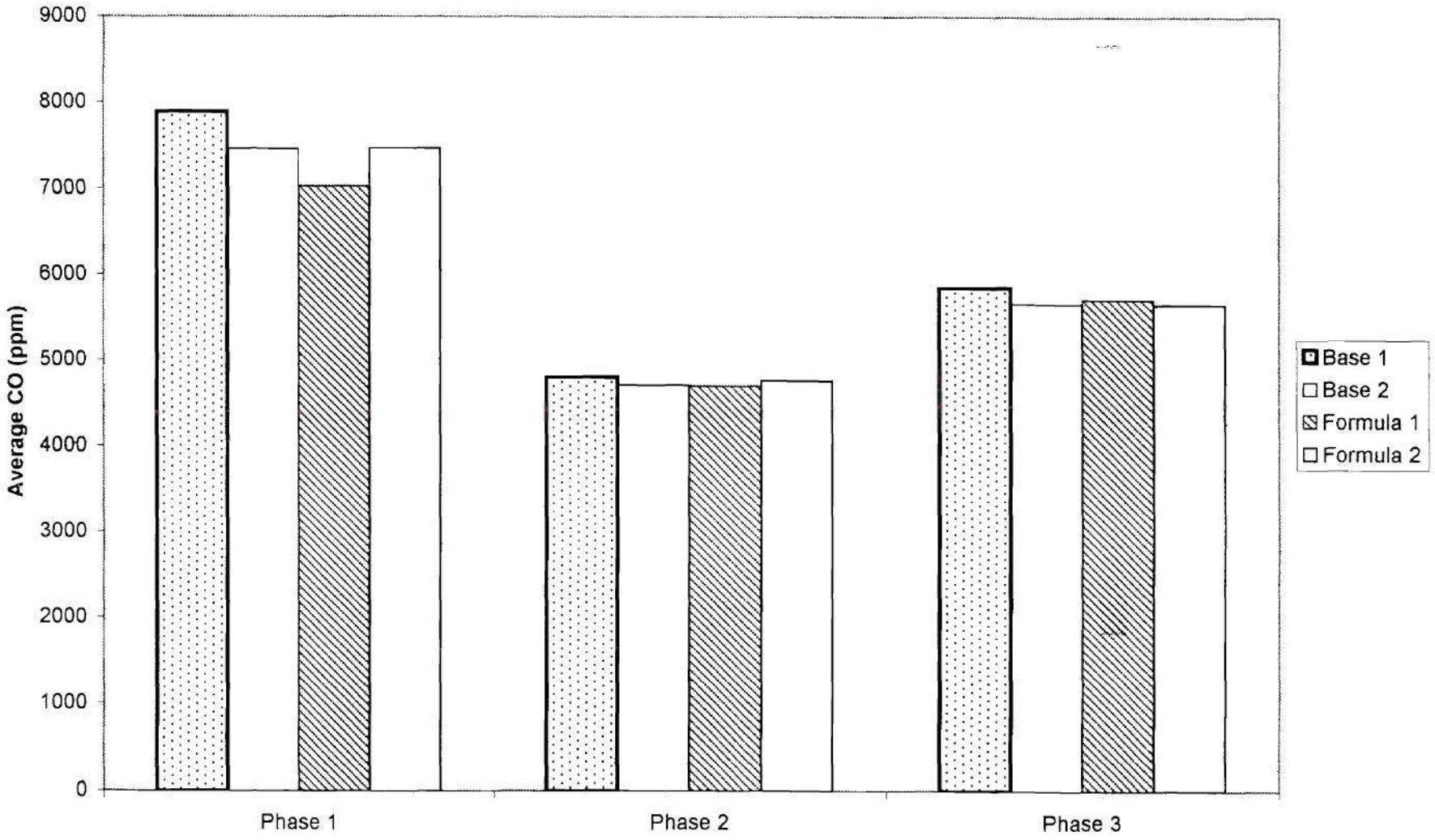

Pontiac Sunbird
CO Modal
Average CO (ppm)
8000
7000
6000
5000
4000
3000
2000
1000
0
Phase 1
Phase 2
Phase 3
Base 1
Base 2
Formula 1
Formula 2


Pontiac Sunbird
NOx Modal
Average NOx (ppm)
1200
1000
800
600
400
200
0
Phase 1
Phase 2
Phase 3
Base 1
Base 2
Formula 1
Formula 2

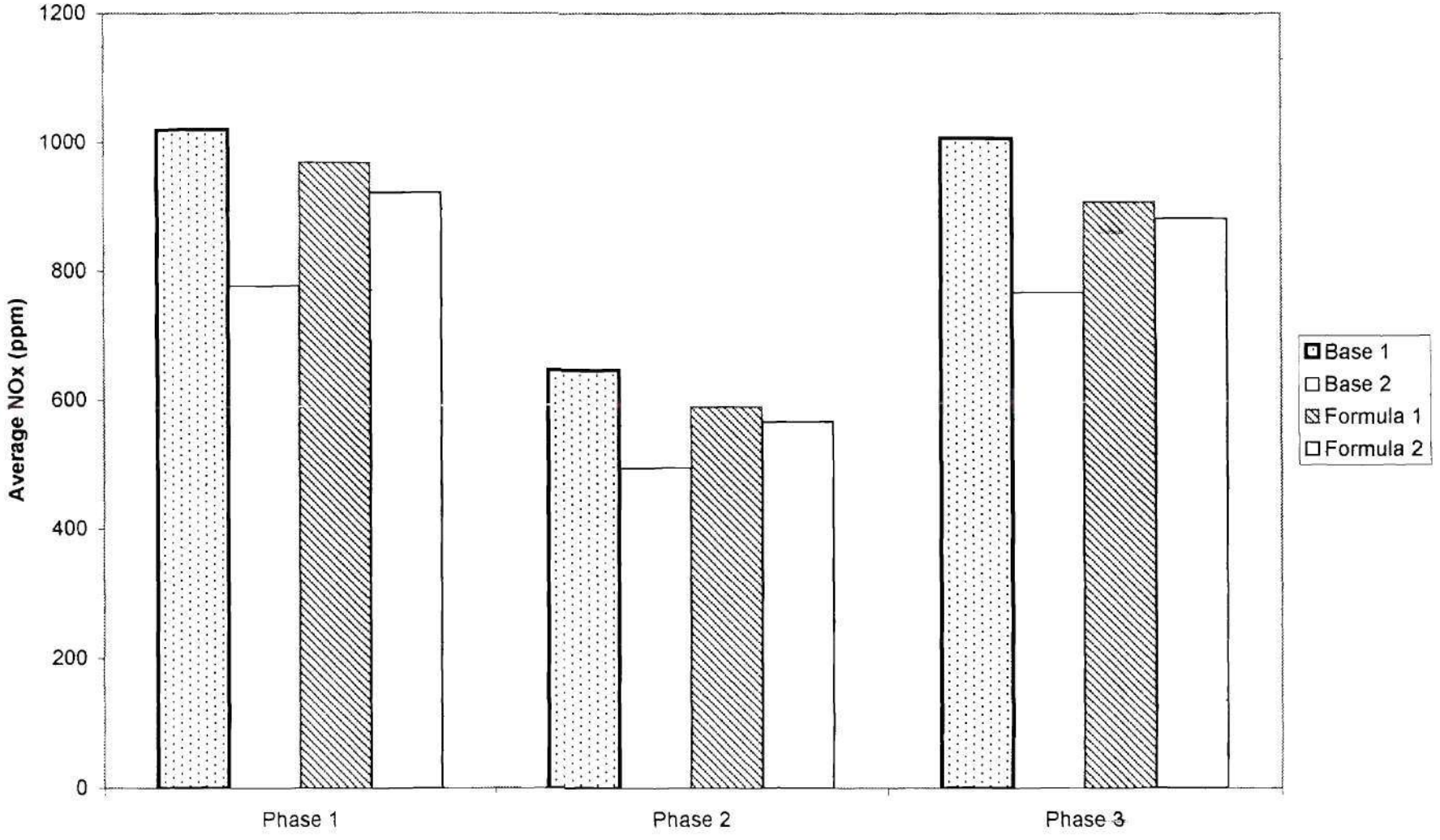
Pontiac Sunbird
Total Hydrocarbon Modal



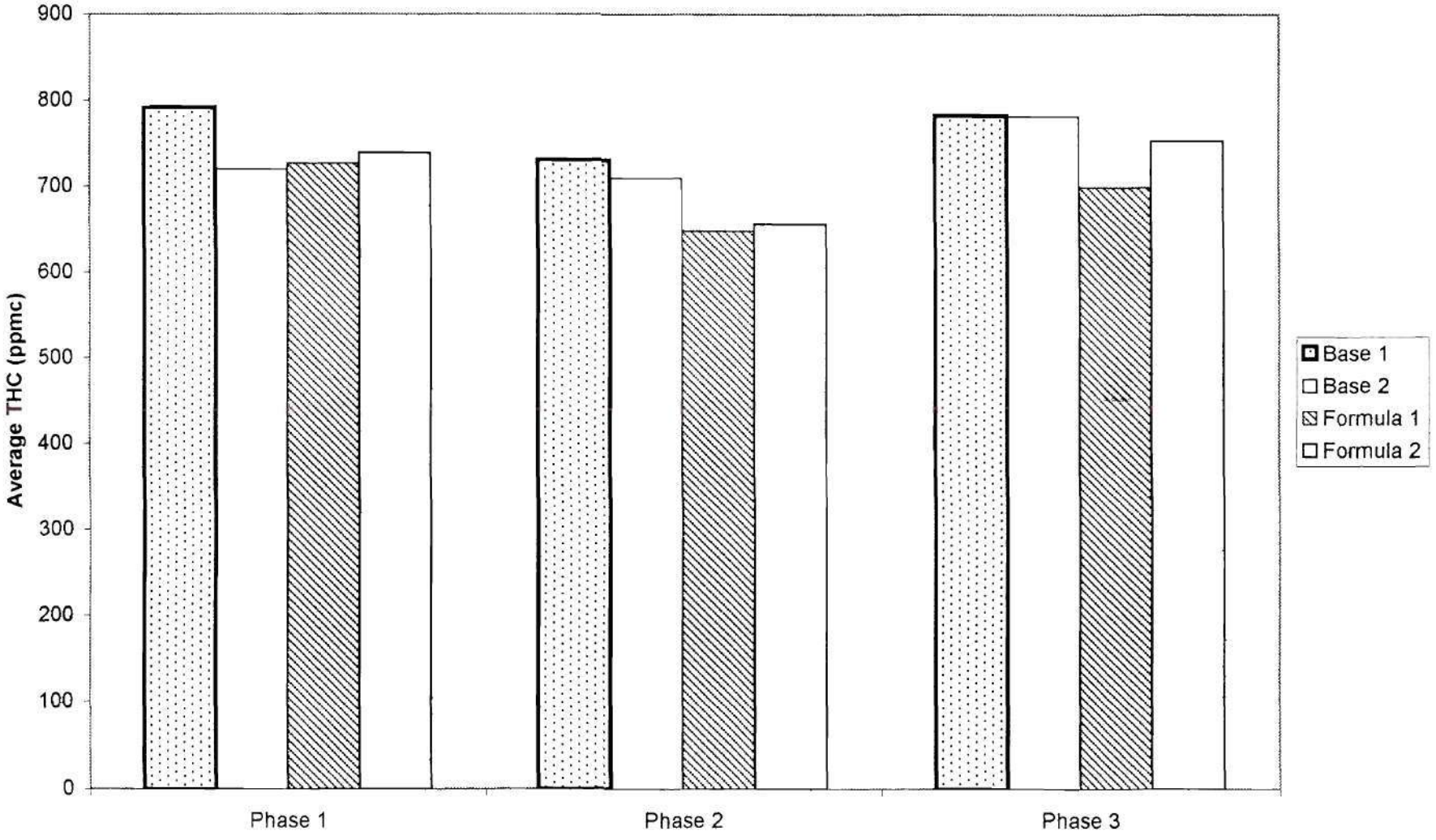
Ford Taurus
CO Engine Out

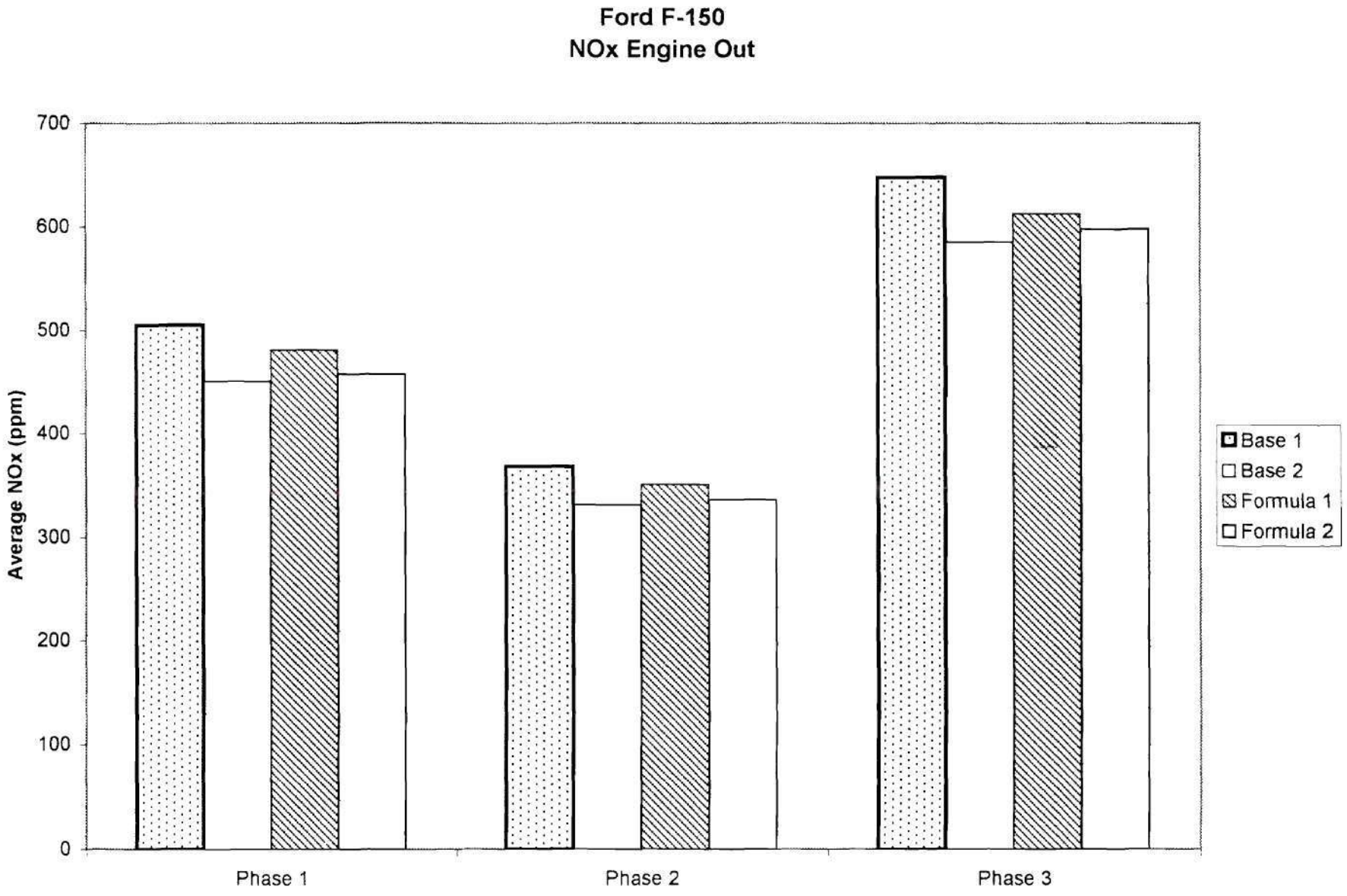


Ford Taurus
NOx Engine Out

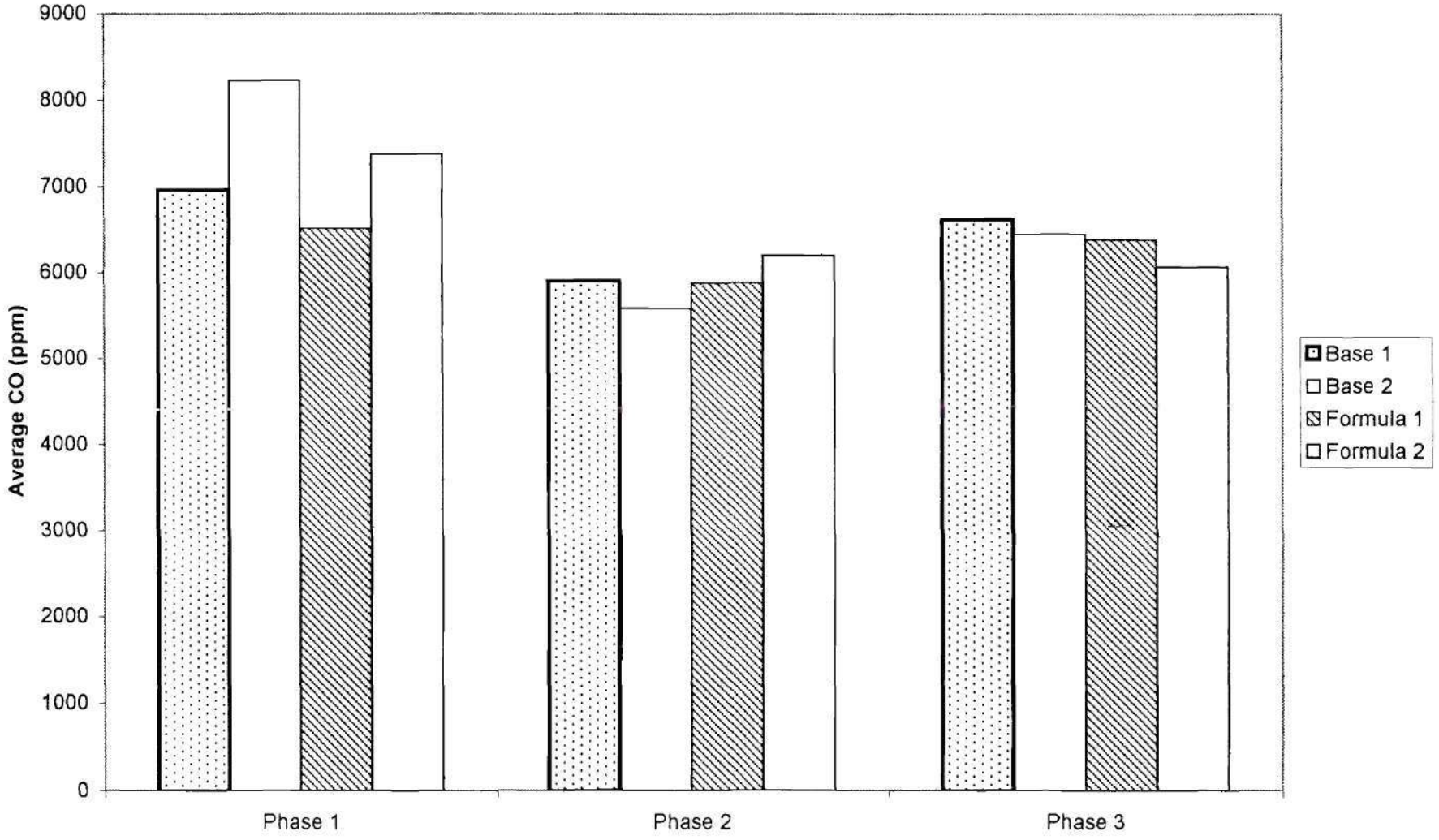


Ford Taurus
Total Hydrocarbon Engine Out

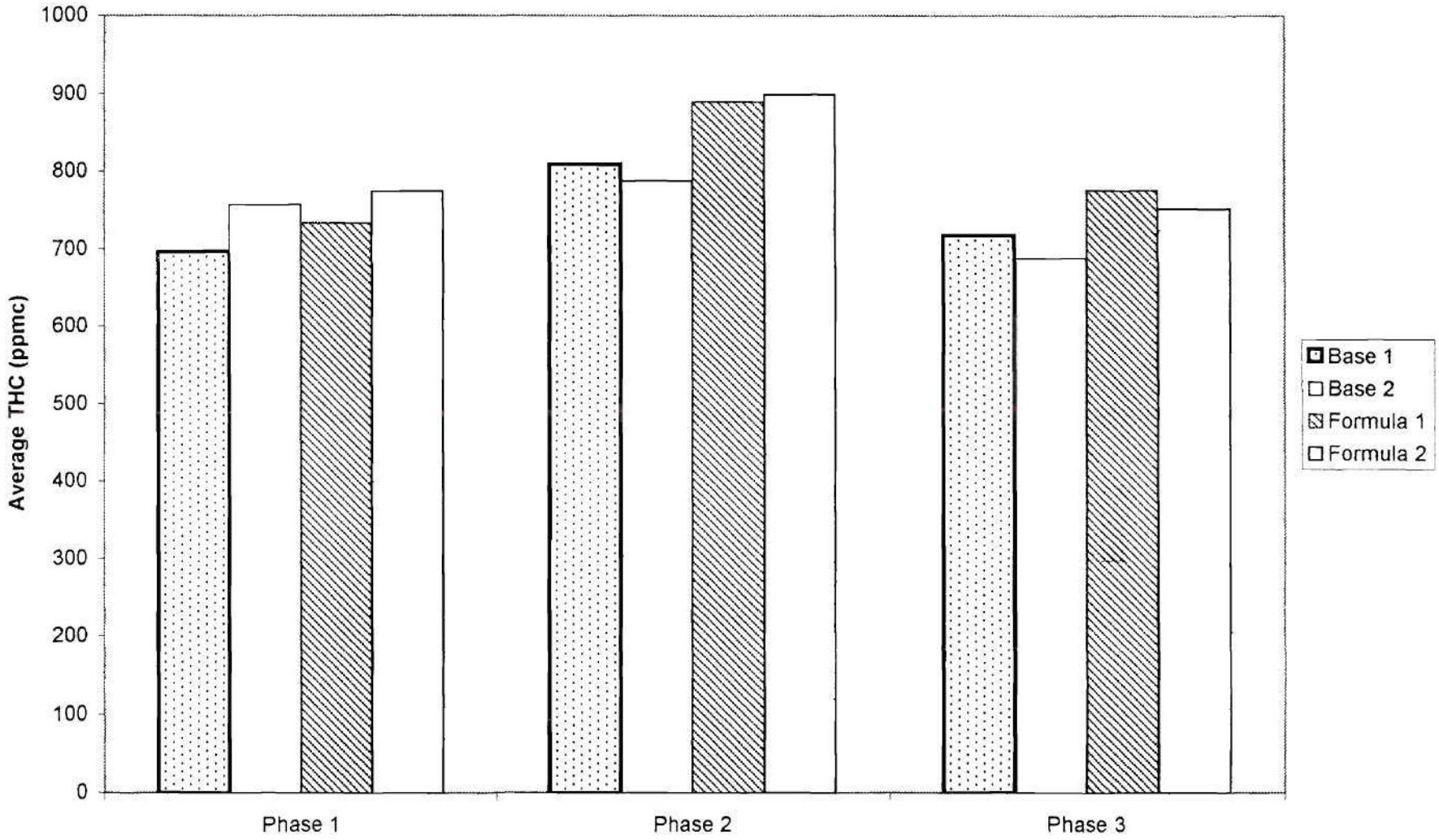



Ford F-150
NOx Engine Out
Average NOx (ppm)
700
600
500
400
300
200
100
0
Phase 1
Phase 2
Phase 3
Base 1
Base 2
Formula 1
Formula 2

Ford F-150
CO Engine Out



Ford F-150
Total Hydrocarbon Engine Out



Conclusions

Based on the results of this study, the fuel additive appears to do little to drastically reduce vehicle emissions. Although some improvements were seen in the reduction of nitrogen oxides, these improvements were offset by increases in carbon monoxide. Although some changes were seen in the engine-out data, on average the changes were within the variability of test-to-test results and not significant. Based on the engine-out results, any catalyst masking effects on emissions were not seen.

This study was a preliminary study to look at the effects of a gasoline addition on emissions for a 4, 6 and 8 cylinder vehicle. Only one vehicle in each engine size was used for the study and there was no control vehicle used in the study. Feature research might include looking at several vehicles in one engine size, including a vehicle used as a control. Other research might look at different fuels and how the additive works with those fuels.

The study also did not address any benefits the additive might have on engine life and maintenance. The accumulation stage was only 1000 miles and that may not have been enough time to see the true potential of the additive. If the additive reduces engine maintenance then there might be some benefit for older vehicles in the fleet.

Appendix A.

Vehicle Photos

Figure A.1 The Pontiac Sunbird

Figure A.2 The Ford Taurus

Figure A.3. The Ford F-150

Appendix B

Vehicle Emission Analysis Sheets

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/15/00
Test No.: 31507 | **Operator:** Pearson | **Time:** 9:00 p

Vehicle Mfg.: Pontiac | **Catalyst:** yes | Fuel: Gasoline
Model/year: Sunbird 94 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1G2JB54H5R7548189 | **Odometer:** 190786.2 | Carbon Wt. Fraction: 0.862
Disp.: 2.0 l | **Inertia Wt./lhp:** 3000/4.7/6.4 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2780.0	4775.0	2785.0
Rolls Count	8469.4	9176.3	8459.0
Miles	3.632	3.936	3.628
Dilution Factor	13.665	20.984	15.382

Ambient Conditions	1	2	3
T wet	65.4	63.2	65.8 °F
T dry	75.9	76.8	80.4 °F
P baro	29.176	29.176	29.176 (in-Hg)
ϕ	56.79	46.42	45.57 %
NOx Corr	1.012	0.956	0.988

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.87	0.59	0.88	0.030	0.029	0.029	2	2	2
Carbon Dioxide %	CO2	0.94	0.61	0.83	0.053	0.050	0.048	1	1	1
Oxides of Nitrogen	NOX	0.29	0.18	0.32	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.44	0.35	0.33	0.101	0.095	0.094	2	2	2
Methane	CH4	0.09	0.07	0.08	0.034	0.034	0.033	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	259.650	176.940	263.670	8.880	8.640	8.640	23.044	26.561	23.469	6.589
Carbon Dioxide*	CO2	0.941	0.611	0.835	0.053	0.050	0.048	1285	1393	1140	343.0
Oxides of Nitrogen	NOX	29.170	18.310	31.760	0.530	0.480	0.470	4.370	4.413	4.666	1.183
Total Hydrocarbons	THC	133.140	103.890	99.750	30.300	28.620	28.140	4.769	5.976	3.340	1.313
Methane	CH4	8.830	6.920	7.670	3.370	3.370	3.270	0.300	0.335	0.243	0.080
non-Methane HC's	NMHC	124.310	96.970	92.080	26.930	25.250	24.870	4.510	5.686	3.130	1.244
NMHC/THC	%	93.368	93.339	92.311	88.878	88.225	88.380	94.568	95.158	93.719	94.760

Fuel Economy : 24.68 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 1.245
Engine Family #: R1G2.0V7GFEA | **CO#:** | **Kit:**
Comment: R1G1046AYMOA oc/twc/air/ho2s/egr/sfi | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/16/00
Test No.: 31601 | **Operator:** Pearson | **Time:** 2:00 p

Vehicle Mfg.:	Pontiac	**Catalyst:**	yes	Fuel:	Gasoline
Model/year:	Sunbird 94	**Wt. Class:**	car	Specific Gravity:	0.732
VIN:	1G2JB54H5R7548189	**Odometer:**	190797.6	Carbon Wt. Fraction:	0.862
Disp.:	2.0 l	**Inertia Wt./lhp:**	3000/4.7/6.4	H/C Ratio:	1.877
Transmission:	AUTO	**A/C:**	yes	LHV (btu/lbm)	18403

	1	2	3
Vmix (scf)	2746.0	4714.0	2742.0
Rolls Count	8507.0	9129.6	8464.7
Miles	3.649	3.916	3.630
Dilution Factor	13.926	20.960	15.249

Ambient Conditions	1	2	3	
T wet	70.3	69.7	70.1	°F
T dry	76.3	77.4	78.1	°F
P baro	28.966	28.871	28.931	(in-Hg)
ϕ	74.33	68.11	67.25	%
NOx Corr	1.159	1.130	1.135	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.81	0.58	0.87	0.024	0.024	0.025	2	2	2
Carbon Dioxide %	CO2	0.93	0.61	0.84	0.046	0.048	0.048	1	1	1
Oxides of Nitrogen	NOX	0.27	0.16	0.29	0.004	0.004	0.004	2	2	2
Total Hydrocarbons	THC	0.42	0.35	0.33	0.112	0.104	0.124	2	2	2
Methane	CH4	0.07	0.05	0.06	0.018	0.018	0.021	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	242.220	174.420	260.040	7.200	7.290	7.500	21.324	26.029	22.875	6.386
Carbon Dioxide*	CO2	0.925	0.612	0.843	0.046	0.048	0.048	1255	1383	1133	340.0
Oxides of Nitrogen	NOX	27.050	15.640	28.550	0.430	0.390	0.390	4.596	4.403	4.751	1.203
Total Hydrocarbons	THC	126.960	103.770	100.230	33.600	31.170	37.080	4.295	5.703	2.937	1.221
Methane	CH4	7.130	5.220	6.480	1.820	1.800	2.070	0.282	0.312	0.235	0.075
non-Methane HC's	NMHC	119.830	98.550	93.750	31.780	29.370	35.010	4.051	5.433	2.733	1.156
NMHC/THC	%	94.384	94.970	93.535	94.583	94.225	94.417	94.319	95.268	93.069	94.679

Fuel Economy : 24.93 (mi/gal) — Reactivity Adjusted NMOG (g/mile): 1.157
Engine Family #: R1G2.0V7GFEA **CO#:** **Kit:**
Comment: R1G1046AYMOA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/19/00
Test No.: 31901 | **Operator:** Pearson | **Time:** 4:00 p

Vehicle Mfg.: Pontiac | **Catalyst:** yes | Fuel: Gasoline
Model/year: Sunbird 94 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1G2JB54H5R7548189 | **Odometer:** 191856.9 | Carbon Wt. Fraction: 0.862
Disp.: 2.0 l | **Inertia Wt./lhp:** 3000/4.7/6.4 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2754.0	4754.0	2766.0
Rolls Count	8490.6	9148.7	8474.0
Miles	3.642	3.924	3.634
Dilution Factor	14.148	21.914	15.985

Ambient Conditions	1	2	3	
T wet	62.2	62.1	63.8	°F
T dry	72.4	73.9	76	°F
P baro	29.026	29.001	28.991	(in-Hg)
ϕ	55.97	50.91	50.83	%
NOx Corr	0.968	0.955	0.977	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.89	0.62	0.86	0.034	0.035	0.031	2	2	2
Carbon Dioxide %	CO2	0.91	0.58	0.80	0.047	0.047	0.043	1	1	1
Oxides of Nitrogen	NOX	0.18	0.13	0.17	0.005	0.004	0.004	2	2	2
Total Hydrocarbons	THC	0.49	0.44	0.39	0.231	0.199	0.169	2	2	2
Methane	CH4	0.09	0.07	0.08	0.027	0.026	0.028	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	266.400	186.840	258.840	10.200	10.350	9.330	23.328	27.737	22.807	6.714
Carbon Dioxide*	CO2	0.906	0.580	0.801	0.047	0.047	0.043	1231	1317	1089	326.2
Oxides of Nitrogen	NOX	17.790	12.510	17.420	0.480	0.430	0.410	2.503	2.977	2.493	0.724
Total Hydrocarbons	THC	147.930	131.070	118.170	69.180	59.640	50.610	3.762	5.757	3.195	1.216
Methane	CH4	9.160	6.740	8.040	2.730	2.640	2.790	0.345	0.379	0.283	0.091
non-Methane HC's	NMHC	138.770	124.330	110.130	66.450	57.000	47.820	3.464	5.429	2.950	1.137
NMHC/THC	%	93.808	94.858	93.196	96.054	95.573	94.487	92.082	94.308	92.330	93.525

Fuel Economy : 25.90 (mi/gal) — Reactivity Adjusted NMOG (g/mile): 1.138
Engine Family #: R1G2.0V7GFEA **CO#:** **Kit:**
Comment: R1G1046AYMOA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/20/00
Test No.: 32002 | **Operator:** Pearson | **Time:** 6:35 a

Vehicle Mfg.: Pontiac | **Catalyst:** yes | Fuel: Gasoline
Model/year: Sunbird 94 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1G2JB54H5R7548189 | **Odometer:** 191868.3 | Carbon Wt. Fraction: 0.862
Disp.: 2.0 l | **Inertia Wt./Ihp:** 3000/4.7/6.4 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2762.0	4737.0	2765.0
Rolls Count	8518.0	9204.7	8493.5
Miles	3.653	3.948	3.643
Dilution Factor	14.254	21.290	15.755

Ambient Conditions	1	2	3	
T wet	64.4	65.4	65.6	°F
T dry	70.2	75.4	75	°F
P baro	28.931	28.946	28.966	(in-Hg)
ϕ	73.00	58.46	60.50	%
NOx Corr	1.036	1.020	1.028	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.90	0.65	0.82	0.047	0.044	0.041	2	2	2
Carbon Dioxide %	CO2	0.90	0.59	0.81	0.047	0.044	0.045	1	1	1
Oxides of Nitrogen	NOX	0.19	0.13	0.19	0.004	0.003	0.004	2	2	2
Total Hydrocarbons	THC	0.58	0.51	0.46	0.228	0.222	0.212	2	2	2
Methane	CH4	0.08	0.06	0.07	0.021	0.025	0.022	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	268.710	196.290	245.310	13.980	13.230	12.420	23.286	28.687	21.303	6.694
Carbon Dioxide*	CO2	0.896	0.595	0.812	0.047	0.044	0.045	1220	1355	1104	330.3
Oxides of Nitrogen	NOX	18.900	13.470	18.970	0.390	0.320	0.350	2.874	3.444	2.869	0.831
Total Hydrocarbons	THC	175.140	152.850	138.000	68.370	66.510	63.540	5.032	6.921	3.544	1.462
Methane	CH4	7.880	5.920	7.050	2.130	2.450	2.150	0.308	0.321	0.263	0.079
non-Methane HC's	NMHC	167.260	146.930	130.950	66.240	64.060	61.390	4.766	6.643	3.317	1.393
NMHC/THC	%	95.501	96.127	94.891	96.885	96.316	96.616	94.712	95.993	93.584	95.305

Fuel Economy : 25.54 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 1.394
Engine Family #: R1G2.0V7GFEA | **CO#:** | **Kit:**
Comment: R1G1046AYMOA oc/twc/air/ho2s/egr/sfi | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/21/00
Test No.: 32103 | **Operator:** Pearson | **Time:** 4:30 p

Vehicle Mfg.: Pontiac | **Catalyst:** yes | Fuel: Gasoline
Model/year: Sunbird 94 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1G2JB54H5R7548189 | **Odometer:** 191880 | Carbon Wt. Fraction: 0.862
Disp.: 2.0 l | **Inertia Wt./Ihp:** 3000/4.7/6.4 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2790.0	4789.0	2788.0
Rolls Count	8499.0	9119.2	8454.6
Miles	3.645	3.911	3.626
Dilution Factor	14.196	21.756	15.884

Ambient Conditions	1	2	3
T wet	63	63.5	64 °F
T dry	75	76.4	76.8 °F
P baro	29.191	29.186	29.186 (in-Hg)
ϕ	50.80	48.54	49.15 %
NOx Corr	0.964	0.965	0.973

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.89	0.65	0.85	0.046	0.042	0.042	2	2	2
Carbon Dioxide %	CO2	0.90	0.59	0.81	0.045	0.046	0.044	1	1	1
Oxides of Nitrogen	NOX	0.28	0.18	0.31	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.43	0.38	0.35	0.107	0.107	0.099	2	2	2
Methane	CH4	0.11	0.08	0.09	0.030	0.029	0.026	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	266.760	194.310	255.450	13.680	12.540	12.720	23.369	28.791	22.385	6.838
Carbon Dioxide*	CO2	0.904	0.585	0.808	0.045	0.046	0.044	1247	1344	1107	332.8
Oxides of Nitrogen	NOX	27.820	18.420	31.030	0.480	0.490	0.500	3.987	4.493	4.489	1.162
Total Hydrocarbons	THC	129.840	113.940	104.820	32.190	31.950	29.700	4.552	6.527	3.505	1.389
Methane	CH4	11.020	7.980	9.490	2.970	2.880	2.560	0.435	0.473	0.373	0.116
non-Methane HC's	NMHC	118.820	105.960	95.330	29.220	29.070	27.140	4.176	6.118	3.182	1.289
NMHC/THC	%	91.513	92.996	90.946	90.774	90.986	91.380	91.734	93.731	90.789	92.797

Fuel Economy : 25.36 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 1.290
Engine Family #: R1G2.0V7GFEA | **CO#:** | **Kit:**
Comment: R1G1046AYMOA egr/twc/o2s | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/15/00
Test No.: 31505 | **Operator:** Pearson | **Time:** 4:20 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: Taurus 95 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FALP52U1SA117675 | **Odometer:** 32989 | Carbon Wt. Fraction: 0.868
Disp.: 3.0 L V6 | **Inertia Wt./Ihp:** 3500/4.9/6.8 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2765.0	4749.0	2757.0
Rolls Count	8441.7	9133.8	8468.7
Miles	3.621	3.917	3.632
Dilution Factor	11.031	18.184	13.203

Ambient Conditions	1	2	3	
T wet	63.7	62.3	61.6	°F
T dry	77.6	75.1	73.9	°F
P baro	29.181	29.181	29.186	(in-Hg)
ϕ	45.95	48.03	49.00	%
NOx Corr	0.961	0.949	0.943	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.89	0.13	0.37	0.025	0.023	0.020	2	2	2
Carbon Dioxide %	CO2	1.18	0.73	1.00	0.050	0.044	0.045	1	1	1
Oxides of Nitrogen	NOX	0.14	0.05	0.13	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.27	0.10	0.13	0.101	0.091	0.093	2	2	2
Methane	CH4	0.06	0.04	0.05	0.027	0.031	0.029	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	267.000	39.000	111.000	7.500	6.900	6.000	23.719	5.085	9.586	2.751
Carbon Dioxide*	CO2	1.180	0.730	1.000	0.050	0.044	0.045	1625	1694	1369	420.6
Oxides of Nitrogen	NOX	13.600	5.400	13.300	0.500	0.490	0.520	1.891	1.205	1.806	0.404
Total Hydrocarbons	THC	81.000	30.000	37.860	30.270	27.390	27.930	2.414	0.319	0.542	0.221
Methane	CH4	6.300	4.050	4.860	2.690	3.050	2.930	0.201	0.105	0.112	0.034
non-Methane HC's	NMHC	74.700	25.950	33.000	27.580	24.340	25.000	2.240	0.229	0.445	0.192
NMHC/THC	%	92.222	86.500	87.163	91.113	88.865	89.509	92.793	71.631	82.135	86.767

Fuel Economy : 20.98 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.193
Engine Family #: 3.0L-SFM1045AYMO | **CO#:** | **Kit:**
Comment: SFM3.0V*GFEA Hard Accel. #4 | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/16/00
Test No.: 31602 | **Operator:** Pearson | **Time:** 4:25 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: Taurus 95 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FALP52U1SA117675 | **Odometer:** 33000 | Carbon Wt. Fraction: 0.868
Disp.: 3.0 L V6 | **Inertia Wt./Ihp:** 3500/4.9/6.8 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2753.0	4727.0	2758.0
Rolls Count	8500.5	9176.2	8463.0
Miles	3.646	3.936	3.630
Dilution Factor	12.226	18.884	14.475

Ambient Conditions	1	2	3	
T wet	66	66.4	67	°F
T dry	74.5	75.5	75.5	°F
P baro	28.936	28.931	28.881	(in-Hg)
ϕ	63.72	61.90	64.21	%
NOx Corr	1.043	1.045	1.063	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.86	0.13	0.31	0.020	0.023	0.047	2	2	2
Carbon Dioxide %	CO2	1.06	0.70	0.91	0.040	0.040	0.050	1	1	1
Oxides of Nitrogen	NOX	0.15	0.05	0.12	0.005	0.005	0.004	2	2	2
Total Hydrocarbons	THC	0.34	0.19	0.21	0.238	0.186	0.197	2	2	2
Methane	CH4	0.06	0.04	0.05	0.026	0.024	0.024	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	259.200	39.000	93.000	6.000	6.900	14.100	23.027	5.060	7.263	2.521
Carbon Dioxide*	CO2	1.060	0.700	0.910	0.040	0.040	0.050	1460	1622	1234	389.9
Oxides of Nitrogen	NOX	14.900	4.700	11.850	0.500	0.500	0.400	2.245	1.131	1.822	0.414
Total Hydrocarbons	THC	101.100	56.940	64.320	71.400	55.800	59.100	1.598	0.316	0.419	0.164
Methane	CH4	5.850	3.540	4.620	2.610	2.390	2.410	0.180	0.114	0.124	0.035
non-Methane HC's	NMHC	95.250	53.400	59.700	68.790	53.410	56.690	1.442	0.000	0.312	0.105
NMHC/THC	%	94.214	93.783	92.817	96.345	95.717	95.922	90.283	0.003	74.454	64.246

Fuel Economy : 22.64 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.106
Engine Family #: 3.0L-SFM1045AYMO | **CO#:** | **Kit:**
Comment: SFM3.0V*GFEA 2twc/2ho2s/egr/sfi | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/20/00
Test No.: 32005 | **Operator:** Pearson | **Time:** 8:00 p

Vehicle Mfg.:	Ford	**Catalyst:**	yes	Fuel:	Gasoline
Model/year:	Taurus 95	**Wt. Class:**	car	Specific Gravity:	0.744
VIN:	1FALP52U1SA117675	**Odometer:**	34039.4	Carbon Wt. Fraction:	0.868
Disp.:	3.0 L V6	**Inertia Wt./Ihp:**	3500/4.9/6.8	H/C Ratio:	1.877
Transmission:	AUTO	**A/C:**	yes	LHV (btu/lbm)	18448

	1	2	3
Vmix (scf)	2775.0	4760.0	2776.0
Rolls Count	8537.2	9199.6	8466.0
Miles	3.662	3.946	3.631
Dilution Factor	12.016	19.073	14.724

Ambient Conditions	1	2	3	
T wet	62.4	64.1	64.5	°F
T dry	73.4	77	77.3	°F
P baro	29.078	29.078	29.088	(in-Hg)
ϕ	53.51	48.99	49.52	%
NOx Corr	0.964	0.975	0.982	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.80	0.13	0.31	0.027	0.025	0.025	2	2	2
Carbon Dioxide %	CO2	1.08	0.70	0.90	0.044	0.045	0.044	1	1	1
Oxides of Nitrogen	NOX	0.17	0.06	0.14	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.24	0.09	0.13	0.075	0.082	0.109	2	2	2
Methane	CH4	0.05	0.03	0.04	0.016	0.017	0.021	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	240.720	39.060	94.230	7.980	7.470	7.590	21.355	5.019	7.977	2.468
Carbon Dioxide*	CO2	1.084	0.696	0.897	0.044	0.045	0.044	1500	1611	1230	389.7
Oxides of Nitrogen	NOX	17.170	6.170	14.290	0.500	0.450	0.450	2.422	1.444	2.047	0.481
Total Hydrocarbons	THC	72.360	28.440	37.800	22.530	24.660	32.610	2.343	0.394	0.336	0.210
Methane	CH4	5.270	3.070	3.940	1.620	1.740	2.110	0.198	0.128	0.103	0.036
non-Methane HC's	NMHC	67.090	25.370	33.860	20.910	22.920	30.500	2.172	0.284	0.246	0.179
NMHC/THC	%	92.717	89.205	89.577	92.810	92.944	93.530	92.680	71.984	73.351	85.223

Fuel Economy : 22.65 (mi/gal) — Reactivity Adjusted NMOG (g/mile): 0.180
Engine Family #: 3.0L-SFM1045AYMO **CO#:** **Kit:**
Comment: SFM3.0V*GFEA 2twc/2ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/21/00
Test No.: 32102 | **Operator:** Pearson | **Time:** 2:40 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: Taurus 95 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FALP52U1SA117675 | **Odometer:** 34050.5 | Carbon Wt. Fraction: 0.868
Disp.: 3.0 L V6 | **Inertia Wt./Ihp:** 3500/4.9/6.8 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2787.0	4775.0	2783.0
Rolls Count	8498.3	9097.9	8448.9
Miles	3.645	3.902	3.624
Dilution Factor	12.530	19.550	14.920

Ambient Conditions	1	2	3	
T wet	63.8	64	64.5	°F
T dry	76.1	78.3	77.8	°F
P baro	29.206	29.191	29.191	(in-Hg)
ϕ	50.43	45.11	48.10	%
NOx Corr	0.973	0.962	0.977	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.79	0.13	0.31	0.033	0.031	0.032	2	2	2
Carbon Dioxide %	CO2	1.04	0.68	0.89	0.046	0.043	0.044	1	1	1
Oxides of Nitrogen	NOX	0.17	0.06	0.14	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.20	0.09	0.12	0.060	0.068	0.091	2	2	2
Methane	CH4	0.07	0.04	0.06	0.029	0.028	0.031	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	236.760	39.810	94.440	9.750	9.210	9.630	20.931	4.892	7.841	2.436
Carbon Dioxide*	CO2	1.040	0.679	0.885	0.046	0.043	0.044	1440	1579	1217	383.8
Oxides of Nitrogen	NOX	16.650	6.040	14.280	0.480	0.480	0.480	2.381	1.390	2.036	0.474
Total Hydrocarbons	THC	61.230	26.310	36.000	18.120	20.520	27.180	2.028	0.533	0.484	0.223
Methane	CH4	7.010	4.280	5.690	2.860	2.780	3.050	0.230	0.148	0.150	0.044
non-Methane HC's	NMHC	54.220	22.030	30.310	15.260	17.740	24.130	1.829	0.405	0.354	0.185
NMHC/THC	%	88.551	83.732	84.194	84.216	86.452	88.779	90.174	75.990	73.271	82.894

Fuel Economy : 23.00 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.186
Engine Family #: 3.0L-SFM1045AYMO | **CO#:** | **Kit:**
Comment: SFM3.0V*GFEA 2twc/2ho2s/egr/sfi | *CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/15/00
Test No.: 31506 | **Operator:** Pearson | **Time:** 7:30 p

Vehicle Mfg.:	Ford	**Catalyst:**	yes	Fuel:	Gasoline
Model/year:	F150 1994	**Wt. Class:**	car	Specific Gravity:	0.744
VIN:	1FTEF14N1RNA69201	**Odometer:**	83593.4	Carbon Wt. Fraction:	0.868
Disp.:	5.0L	**Inertia Wt./lhp:**	5250/13.1/15.9	H/C Ratio:	1.877
Transmission:	AUTO	**A/C:**	yes	LHV (btu/lbm)	18448

	1	2	3
Vmix (scf)	2763.0	4736.0	2757.0
Rolls Count	8491.0	9228.0	8486.4
Miles	3.642	3.958	3.640
Dilution Factor	8.552	13.878	10.176

Ambient Conditions	1	2	3	
T wet	63	64.2	66	°F
T dry	70.9	79	82.5	°F
P baro	29.186	29.171	29.165	(in-Hg)
ϕ	64.28	43.98	41.16	%
NOx Corr	0.994	0.962	0.977	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.73	0.22	0.62	0.023	0.023	0.024	2	2	2
Carbon Dioxide %	CO2	1.54	0.95	1.29	0.044	0.044	0.042	1	1	1
Oxides of Nitrogen	NOX	0.23	0.11	0.27	0.006	0.006	0.004	2	2	2
Total Hydrocarbons	THC	0.29	0.17	0.24	0.087	0.086	0.078	2	2	2
Methane	CH4	0.10	0.07	0.08	0.031	0.029	0.030	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/miie)
Carbon Monoxide	CO	219.210	66.900	185.400	6.810	6.990	7.140	19.421	9.433	16.267	3.561
Carbon Dioxide*	CO2	1.536	0.954	1.291	0.044	0.044	0.042	2144	2240	1790	550.4
Oxides of Nitrogen	NOX	23.180	10.920	27.320	0.560	0.550	0.440	3.373	2.568	3.929	0.824
Total Hydrocarbons	THC	88.320	51.990	70.530	26.190	25.920	23.400	2.941	2.161	2.225	0.618
Methane	CH4	9.690	7.180	8.130	3.080	2.870	3.000	0.364	0.404	0.283	0.095
non-Methane HC's	NMHC	78.630	44.810	62.400	23.110	23.050	20.400	2.627	1.811	1.981	0.536
NMHC/THC	%	89.029	86.190	88.473	88.240	88.927	87.179	89.308	83.833	89.025	86.711

Fuel Economy : 16.00 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.537
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
*CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/16/00
Test No.: 31603 | **Operator:** Pearson | **Time:** 8:10 p

Vehicle Mfg.: Ford	**Catalyst:** yes	Fuel: Gasoline	
Model/year: F150 1994	**Wt. Class:** car	Specific Gravity: 0.744	
VIN: 1FTEF14N1RNA69201	**Odometer:** 83607.8	Carbon Wt. Fraction: 0.868	
Disp.: 5.0L	**Inertia Wt./Ihp:** 5250/13.1/15.9	H/C Ratio: 1.877	
Transmission: AUTO	**A/C:** yes	LHV (btu/lbm) 18448	

	1	2	3
Vmix (scf)	2747.0	4711.0	2754.0
Rolls Count	8508.7	9181.2	8488.1
Miles	3.649	3.938	3.641
Dilution Factor	8.295	13.745	10.083

Ambient Conditions	1	2	3	
T wet	65.1	66.7	66.9	°F
T dry	70.9	75.3	76.2	°F
P baro	28.978	28.976	28.976	(in-Hg)
ϕ	73.25	63.70	61.48	%
NOx Corr	1.048	1.054	1.052	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.84	0.25	0.55	0.026	0.025	0.025	2	2	2
Carbon Dioxide %	CO2	1.58	0.96	1.31	0.045	0.042	0.044	1	1	1
Oxides of Nitrogen	NOX	0.20	0.10	0.23	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.44	0.20	0.23	0.152	0.140	0.119	2	2	2
Methane	CH4	0.13	0.08	0.09	0.037	0.032	0.033	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	251.250	73.890	165.450	7.920	7.410	7.500	22.125	10.410	14.409	3.711
Carbon Dioxide*	CO2	1.577	0.962	1.306	0.045	0.042	0.044	2188	2252	1807	556.9
Oxides of Nitrogen	NOX	20.040	10.000	23.040	0.500	0.500	0.500	3.056	2.565	3.545	0.778
Total Hydrocarbons	THC	132.390	60.000	69.000	45.600	42.000	35.640	4.140	1.620	1.659	0.573
Methane	CH4	12.930	7.950	8.650	3.680	3.190	3.260	0.503	0.444	0.297	0.109
non-Methane HC's	NMHC	119.460	52.050	60.350	41.920	38.810	32.380	3.705	1.236	1.402	0.478
NMHC/THC	%	90.233	86.750	87.464	91.930	92.405	90.853	89.496	76.291	84.515	83.488

Fuel Economy : 15.82 (mi/gal) — Reactivity Adjusted NMOG (g/mile): 0.479
Engine Family #: RFM1045AYMOA **CO#:** **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/20/00
Test No.: 32004 | **Operator:** Pearson | **Time:** 7:00 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: F150 1994 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FTEF14N1RNA69201 | **Odometer:** 84628.8 | Carbon Wt. Fraction: 0.868
Disp.: 5.0L | **Inertia Wt./Ihp:** 5250/13.1/15.9 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2756.0	4732.0	2759.0
Rolls Count	8510.0	9144.7	8458.5
Miles	3.650	3.922	3.628
Dilution Factor	8.603	14.029	10.101

Ambient Conditions	1	2	3	
T wet	63	64	65.4	°F
T dry	85.2	78.8	80.8	°F
P baro	29.044	29.046	29.061	(in-Hg)
ϕ	27.55	43.90	43.38	%
NOx Corr	0.899	0.961	0.977	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.86	0.24	0.57	0.025	0.023	0.024	2	2	2
Carbon Dioxide %	CO2	1.52	0.94	1.30	0.045	0.043	0.044	1	1	1
Oxides of Nitrogen	NOX	0.18	0.08	0.21	0.005	0.004	0.042	2	2	2
Total Hydrocarbons	THC	0.31	0.15	0.22	0.083	0.085	0.087	2	2	2
Methane	CH4	0.09	0.06	0.06	0.017	0.019	0.017	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	259.260	73.350	172.080	7.500	6.810	7.140	22.955	10.457	15.068	3.824
Carbon Dioxide*	CO2	1.522	0.943	1.303	0.045	0.043	0.044	2117	2214	1806	549.5
Oxides of Nitrogen	NOX	17.540	8.310	20.930	0.510	0.440	4.200	2.294	1.945	2.504	0.577
Total Hydrocarbons	THC	92.970	45.210	66.450	24.930	25.410	26.190	3.193	1.670	1.931	0.548
Methane	CH4	8.970	6.140	6.490	1.740	1.870	1.710	0.387	0.394	0.258	0.094
non-Methane HC's	NMHC	84.000	39.070	59.960	23.190	23.540	24.480	2.858	1.330	1.708	0.467
NMHC/THC	%	90.352	86.419	90.233	93.020	92.641	93.471	89.523	79.625	88.451	85.247

Fuel Economy : 16.03 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.468
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/21/00
Test No.: 32101 | **Operator:** Pearson | **Time:** 1:30 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: F150 1994 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1FTEF14N1RNA69201 | **Odometer:** 84640.1 | Carbon Wt. Fraction: 0.862
Disp.: 5.0L | **Inertia Wt./Ihp:** 5250/13.1/15.9 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2760.0	4738.0	2762.0
Rolls Count	8466.0	9132.9	8453.0
Miles	3.631	3.917	3.625
Dilution Factor	8.396	13.940	10.120

Ambient Conditions	1	2	3
T wet	65.4	66.7	66.9 °F
T dry	78.6	83.1	82.8 °F
P baro	29.221	29.205	29.215 (in-Hg)
ϕ	48.94	41.85	43.13 %
NOx Corr	0.991	0.989	0.996

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.85	0.24	0.52	0.027	0.026	0.025	2	2	2
Carbon Dioxide %	CO2	1.56	0.95	1.30	0.045	0.043	0.043	1	1	1
Oxides of Nitrogen	NOX	0.21	0.09	0.25	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.33	0.15	0.19	0.094	0.107	0.084	2	2	2
Methane	CH4	0.14	0.10	0.10	0.033	0.032	0.029	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	255.330	73.230	156.480	8.100	7.770	7.440	22.585	10.313	13.639	3.684
Carbon Dioxide*	CO2	1.561	0.949	1.303	0.045	0.043	0.043	2175	2232	1808	556.3
Oxides of Nitrogen	NOX	20.610	8.920	24.680	0.510	0.540	0.530	2.986	2.136	3.605	0.726
Total Hydrocarbons	THC	98.550	45.480	58.200	28.050	32.010	25.230	3.328	1.220	1.600	0.472
Methane	CH4	14.230	9.500	9.500	3.290	3.150	2.870	0.591	0.589	0.361	0.139
non-Methane HC's	NMHC	84.320	35.980	48.700	24.760	28.860	22.360	2.817	0.711	1.288	0.352
NMHC/THC	%	85.561	79.112	83.677	88.271	90.159	88.625	84.654	58.291	80.505	74.564

Fuel Economy : 15.65 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.353
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/h02s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/16/00
Test No.: 31603 | **Operator:** Pearson | **Time:** 8:10 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: F150 1994 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FTEF14N1RNA69201 | **Odometer:** 83607.8 | Carbon Wt. Fraction: 0.868
Disp.: 5.0L | **Inertia Wt./Ihp:** 5250/13.1/15.9 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2747.0	4711.0	2754.0
Rolls Count	8508.7	9181.2	8488.1
Miles	3.649	3.938	3.641
Dilution Factor	8.295	13.745	10.083

Ambient Conditions	1	2	3	
T wet	65.1	66.7	66.9	°F
T dry	70.9	75.3	76.2	°F
P baro	28.978	28.976	28.976	(in-Hg)
ϕ	73.25	63.70	61.48	%
NOx Corr	1.048	1.054	1.052	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.84	0.25	0.55	0.026	0.025	0.025	2	2	2
Carbon Dioxide %	CO2	1.58	0.96	1.31	0.045	0.042	0.044	1	1	1
Oxides of Nitrogen	NOX	0.20	0.10	0.23	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.44	0.20	0.23	0.152	0.140	0.119	2	2	2
Methane	CH4	0.13	0.08	0.09	0.037	0.032	0.033	2	2	2

		Species Concentration (ppm*)						Mass Emissions			Weighted
		Sample			Background			Mass (grams)			Emissions
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	251.250	73.890	165.450	7.920	7.410	7.500	22.125	10.410	14.409	3.711
Carbon Dioxide*	CO2	1.577	0.962	1.306	0.045	0.042	0.044	2188	2252	1807	556.9
Oxides of Nitrogen	NOX	20.040	10.000	23.040	0.500	0.500	0.500	3.056	2.565	3.545	0.778
Total Hydrocarbons	THC	132.390	60.000	69.000	45.600	42.000	35.640	4.140	1.620	1.659	0.573
Methane	CH4	12.930	7.950	8.650	3.680	3.190	3.260	0.503	0.444	0.297	0.109
non-Methane HC's	NMHC	119.460	52.050	60.350	41.920	38.810	32.380	3.705	1.236	1.402	0.478
NMHC/THC	%	90.233	86.750	87.464	91.930	92.405	90.853	89.496	76.291	84.515	83.488

Fuel Economy : 15.82 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.479
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
*CO2 Concentration reported in %
Quality Checked : Jim Pearson

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/20/00
Test No.: 32004 | **Operator:** Pearson | **Time:** 7:00 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: F150 1994 | **Wt. Class:** car | Specific Gravity: 0.744
VIN: 1FTEF14N1RNA69201 | **Odometer:** 84628.8 | Carbon Wt. Fraction: 0.868
Disp.: 5.0L | **Inertia Wt./lhp:** 5250/13.1/15.9 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18448

	1	2	3
Vmix (scf)	2756.0	4732.0	2759.0
Rolls Count	8510.0	9144.7	8458.5
Miles	3.650	3.922	3.628
Dilution Factor	8.603	14.029	10.101

Ambient Conditions	1	2	3	
T wet	63	64	65.4	°F
T dry	85.2	78.8	80.8	°F
P baro	29.044	29.046	29.061	(in-Hg)
ϕ	27.55	43.90	43.38	%
NOx Corr	0.899	0.961	0.977	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.86	0.24	0.57	0.025	0.023	0.024	2	2	2
Carbon Dioxide %	CO2	1.52	0.94	1.30	0.045	0.043	0.044	1	1	1
Oxides of Nitrogen	NOX	0.18	0.08	0.21	0.005	0.004	0.042	2	2	2
Total Hydrocarbons	THC	0.31	0.15	0.22	0.083	0.085	0.087	2	2	2
Methane	CH4	0.09	0.06	0.06	0.017	0.019	0.017	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	259.260	73.350	172.080	7.500	6.810	7.140	22.955	10.457	15.068	3.824
Carbon Dioxide*	CO2	1.522	0.943	1.303	0.045	0.043	0.044	2117	2214	1806	549.5
Oxides of Nitrogen	NOX	17.540	8.310	20.930	0.510	0.440	4.200	2.294	1.945	2.504	0.577
Total Hydrocarbons	THC	92.970	45.210	66.450	24.930	25.410	26.190	3.193	1.670	1.931	0.548
Methane	CH4	8.970	6.140	6.490	1.740	1.870	1.710	0.387	0.394	0.258	0.094
non-Methane HC's	NMHC	84.000	39.070	59.960	23.190	23.540	24.480	2.858	1.330	1.708	0.467
NMHC/THC	%	90.352	86.419	90.233	93.020	92.641	93.471	89.523	79.625	88.451	85.247

Fuel Economy : 16.03 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.468
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis

Natural Gas Vehicle Southeast E.T.L.
616 Hwy 138 S.E.
Riverdale, GA 30274
(404) 907-5213

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/21/00
Test No.: 32101 | **Operator:** Pearson | **Time:** 1:30 p

Vehicle Mfg.: Ford | **Catalyst:** yes | Fuel: Gasoline
Model/year: F150 1994 | **Wt. Class:** car | Specific Gravity: 0.732
VIN: 1FTEF14N1RNA69201 | **Odometer:** 84640.1 | Carbon Wt. Fraction: 0.862
Disp.: 5.0L | **Inertia Wt./Ihp:** 5250/13.1/15.9 | H/C Ratio: 1.877
Transmission: AUTO | **A/C:** yes | LHV (btu/lbm) 18403

	1	2	3
Vmix (scf)	2760.0	4738.0	2762.0
Rolls Count	8466.0	9132.9	8453.0
Miles	3.631	3.917	3.625
Dilution Factor	8.396	13.940	10.120

Ambient Conditions	1	2	3	
T wet	65.4	66.7	66.9	°F
T dry	78.6	83.1	82.8	°F
P baro	29.221	29.205	29.215	(in-Hg)
ϕ	48.94	41.85	43.13	%
NOx Corr	0.991	0.989	0.996	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.85	0.24	0.52	0.027	0.026	0.025	2	2	2
Carbon Dioxide %	CO2	1.56	0.95	1.30	0.045	0.043	0.043	1	1	1
Oxides of Nitrogen	NOX	0.21	0.09	0.25	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.33	0.15	0.19	0.094	0.107	0.084	2	2	2
Methane	CH4	0.14	0.10	0.10	0.033	0.032	0.029	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	255.330	73.230	156.480	8.100	7.770	7.440	22.585	10.313	13.639	3.684
Carbon Dioxide*	CO2	1.561	0.949	1.303	0.045	0.043	0.043	2175	2232	1808	556.3
Oxides of Nitrogen	NOX	20.610	8.920	24.680	0.510	0.540	0.530	2.986	2.136	3.605	0.726
Total Hydrocarbons	THC	98.550	45.480	58.200	28.050	32.010	25.230	3.328	1.220	1.600	0.472
Methane	CH4	14.230	9.500	9.500	3.290	3.150	2.870	0.591	0.589	0.361	0.139
non-Methane HC's	NMHC	84.320	35.980	48.700	24.760	28.860	22.360	2.817	0.711	1.288	0.352
NMHC/THC	%	85.561	79.112	83.677	88.271	90.159	88.625	84.654	58.291	80.505	74.564

Fuel Economy : 15.65 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.353
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
Quality Checked : Jim Pearson

*CO2 Concentration reported in %

Vehicle Emissions Analysis
Georgia Institute of Technology
Air Quality Laboratory
(770) 603-4786

Customer: Environmental Fuels | **Test Type:** 75 FTP | **Date:** 3/16/00
Test No.: 31603 | **Operator:** Pearson | **Time:** 8:10 p

Vehicle Mfg.: Ford	**Catalyst:** yes	Fuel: Gasoline	
Model/year: F150 1994	**Wt. Class:** car	Specific Gravity: 0.744	
VIN: 1FTEF14N1RNA69201	**Odometer:** 83607.8	Carbon Wt. Fraction: 0.868	
Disp.: 5.0L	**Inertia Wt./Ihp:** 5250/13.1/15.9	H/C Ratio: 1.877	
Transmission: AUTO	**A/C:** yes	LHV (btu/lbm) 18448	

	1	2	3
Vmix (scf)	2747.0	4711.0	2754.0
Rolls Count	8508.7	9181.2	8488.1
Miles	3.649	3.938	3.641
Dilution Factor	8.295	13.745	10.083

Ambient Conditions	1	2	3	
T wet	65.1	66.7	66.9	°F
T dry	70.9	75.3	76.2	°F
P baro	28.978	28.976	28.976	(in-Hg)
ϕ	73.25	63.70	61.48	%
NOx Corr	1.048	1.054	1.052	

		Analyzer Readings						Analyzer Range		
		Sample			Background					
Chemical Species		1	2	3	1	2	3	1	2	3
Carbon Monoxide	CO	0.84	0.25	0.55	0.026	0.025	0.025	2	2	2
Carbon Dioxide %	CO2	1.58	0.96	1.31	0.045	0.042	0.044	1	1	1
Oxides of Nitrogen	NOX	0.20	0.10	0.23	0.005	0.005	0.005	2	2	2
Total Hydrocarbons	THC	0.44	0.20	0.23	0.152	0.140	0.119	2	2	2
Methane	CH4	0.13	0.08	0.09	0.037	0.032	0.033	2	2	2

		Species Concentration (ppm*)						Mass Emissions Mass (grams)			Weighted Emissions
		Sample			Background						
		1	2	3	1	2	3	1	2	3	(g/mile)
Carbon Monoxide	CO	251.250	73.890	165.450	7.920	7.410	7.500	22.125	10.410	14.409	3.711
Carbon Dioxide*	CO2	1.577	0.962	1.306	0.045	0.042	0.044	2188	2252	1807	556.9
Oxides of Nitrogen	NOX	20.040	10.000	23.040	0.500	0.500	0.500	3.056	2.565	3.545	0.778
Total Hydrocarbons	THC	132.390	60.000	69.000	45.600	42.000	35.640	4.140	1.620	1.659	0.573
Methane	CH4	12.930	7.950	8.650	3.680	3.190	3.260	0.503	0.444	0.297	0.109
non-Methane HC's	NMHC	119.460	52.050	60.350	41.920	38.810	32.380	3.705	1.236	1.402	0.478
NMHC/THC	%	90.233	86.750	87.464	91.930	92.405	90.853	89.496	76.291	84.515	83.488

Fuel Economy : 15.82 (mi/gal) | Reactivity Adjusted NMOG (g/mile): 0.479
Engine Family #: RFM1045AYMOA | **CO#:** | **Kit:**
Comment: RFM5.888GBJA oc/twc/air/ho2s/egr/sfi
*CO2 Concentration reported in %
Quality Checked : Jim Pearson